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THE ELECTRIC-CELL PHOTOMETER.

BY W. W. CAMPBELL.

The spectroscope and the photographic dry-plate are very prominent amongst the astronomer's tools, and it is always a pleasure to acknowledge that the physicists and chemists discovered their fundamentals and made the first applications. The physicists are now developing another instrument which may be as important to astronomers as the spectroscope has been.

Studies in the conduction of electricity through gases led to the invention of the photo-electric cell by ELSTER and GEITEL. In its elements this cell consists of a glass bulb, a section of whose inner surface is coated with a deposit of an alkaloid metal, such as potassium or sodium, which contains only a very minute quantity of a suitable gas; and from whose coated and non-coated interior sections lead off, respectively, the two wires of an electric circuit. If the cell is in absolute darkness, no current will pass across the gap in the cell between the terminals of the circuit wires; but if a faint light is permitted to fall upon the alkaloid surface, the rarified gas in the cell becomes a conductor and permits current to pass between the terminals. The quantity of current passing is a function of the illumination; and, conversely, the strength of the current, as measured by an electrometer in the circuit, or by other means, is a measure of the intensity of the illumination.

KOCH of Munich has made some wonderful applications of the electric cell to laboratory photometry: reproducing automatically, on a large scale and with great accuracy, the intensity curves of photographic spectra; even giving strong encouragement, and almost the assurance, that the accurate positions of poorly defined spectral lines can be determined by this

method. KOCH's papers can be found in Wiedemann's *Annalen der Physik* of the past year.

Professor KEMP of the University of Illinois (a colleague of Professor STEBBINS of selenium photometer fame) published a valuable paper in the *Physical Review*, April, 1913, on those features of electric cells which seem to concern their use as the basis of sensitive photometers. By experimentation with cells coated respectively with sodium, potassium, rubidium and cæsium, and containing hydrogen gas at pressures of only a few millimeters, he determined the conditions of voltage, temperature, pressure, and distance between electrodes, which give maximum sensitiveness to the electric cell,—within the range of the experimental program followed. He found that his potassium-hydrogen cell was "about two hundred times more sensitive than the selenium cell." The astronomical applications of the cell were recognized as promising by KEMP when he wrote: "We hope to use these photo-electric cells for the measurement of the light from the fixed stars."

The selenium photometer as developed and applied to the study of variable stars by STEBBINS, in the past five years, had quite out-classed in accuracy all existing forms of photometers; but, early in the summer of 1913, STEBBINS wrote me from Europe that upon returning to Illinois he proposed to lay the selenium photometer on the shelf, at least for a time, and try an electric-cell photometer.

These preliminaries quite prepared me for ROSENBERG's paper, at the Hamburg meeting of the Astronomische Gesellschaft, in August, 1913, in which he presented some remarkable results obtained by MEYER and ROSENBERG with an electric-cell photometer attached to the 5-inch refractor of the Oesterberg Observatory, Tübingen, Germany, in measuring the light of stars between the fifth and sixth magnitudes; as well as for Director STRUVE's remarks on similar observations by GUTHNICK at the new observatory of Berlin University (nearly completed, at Neu-Babelsberg, near Potsdam).

By way of comment on ROSENBERG's paper, STEBBINS went to the blackboard and wrote down the following table, contrasting the work of MEYER and ROSENBERG's electric-cell photometer and his own selenium photometer. The numerical

data may not be exactly correct, as printed below, for I write them down from memory; but they are essentially right.

Photometer.	Telescope.	Star of	Time to Make Observation.	Probable Error of One Determination.
Electric-cell	5-inch	5th mag.	2 min.	± 0.003 mag.
Selenium	12-inch	2nd mag.	60 min.	± 0.01 mag.

A few days following the Hamburg meeting I had the opportunity to see GUTHNICK's photometer attached to a small refractor, and to learn of some remarkable results obtained on certain interesting stars, but it is not for me to describe them.

If the electric-cell photometer, attached to small telescopes, can measure the light of a fifth-magnitude star, in a few minutes, with an accuracy of a few thousandths of a magnitude,—and this on the first trials of the instrument,—we are entering a new era in the study of the variable stars. The conspicuous difficulties may lie in the variable transparency of our atmosphere, or in the variable brightness of comparison stars. It may in fact be found that the star of constant brightness is the exception and not the rule. The electric-cell photometer may become as important a tool as the spectroscope and dry plate are.

August, 1913.

REVIEW.

BY EDWIN B. FROST.

STELLAR MOTIONS, with special reference to motions determined by the spectrograph: The Silliman Lectures, delivered at Yale University by WILLIAM WALLACE CAMPBELL, Sc.D., LL.D., Director of the Lick Observatory, University of California. New Haven: Yale University Press, 1913. 8vo. Pp. 328, with numerous illustrations. Price, \$4.00 net.

The value of endowed lectureships is fortunately not limited to the casual auditors or to the institutions in which they are given, however useful the stimulus of the presence of the guest from without may be to hearers and institutions. The lecturer